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ANTEPIONE THIOSARIA AND *XANTHOTYPE*: A CASE OF MIMICRY

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MIMICRY BEING THE CONTROVERSIAL PHENOMENON it is, the existence of an apparently undescribed case in so well-documented a fauna as that of eastern North America comes as a distinct surprise. The case in question involves a number of special circumstances which greatly enhance its interest and which may have contributed to its nature not having been recognized previously. The insects involved are the species of *Xanthotype* as the presumed models and *Antepione thiosaria*, the mimic (all Geometridae).

Xanthotype is a North American genus of several sibling species, frequently determinable only by the genitalia. All are bright yellow marked with light violet-brown in the manner of the specimens shown in Fig. 1 (right). *A. thiosaria* is an outlier of the large Neotropical *Sabulodes* group, and is distinctive within that group in being strongly seasonably dimorphic; the summer form departs widely from the usual appearance of its relatives, while the spring form is fairly normal. The two genera are in the same subfamily but different tribes (Angeroniini and Ourapterygini respectively) and are not considered closely related.

The spring form of *A. thiosaria* (Fig. 1, left) flies in April and May through most of the range. It is fawn color, about like the related *Prochoerodes transversata* Dru., with no strong contrasts, and a definitely concealing coloration. The summer form (Fig. 1, center) flies in July and August. It shows marked sexual dimorphism (unlike the earlier brood). The male is bright yellow with a red-brown to chocolate-brown border covering the outer half of the wings. The female is entirely bright

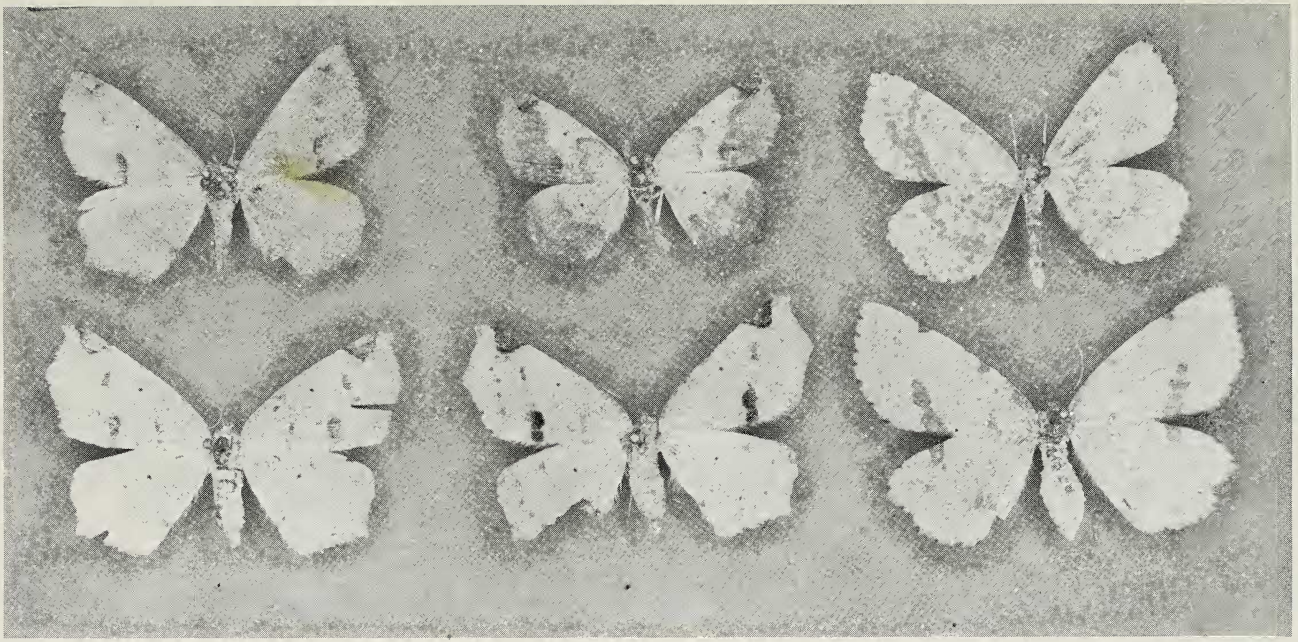

Fig. 1. Left: *Antepione thiosaria,* spring form, Montgomery Co., Pa., V. 1963. Center: *A. thiosaria,* summer form, do., VII. 1964. Right: *Xanthotype sospeta,* do., VII. 1964. Males above, females below.

yellow, without the contrasting border, but with purplish markings representing parts of the complete pattern, and very closely approximating the pattern of the species of *Xanthotype*. Intergrades between the summer and spring forms occur, but are rare. The difference in coloration is controlled entirely by the temperature environment of the pupa.

The limitation of the resemblance to *Xanthotype* to the summer brood of *thiosaria* becomes more reasonable when the flight periods of the presumed models are considered. In the northeastern United States there are two *Xanthotype*: a very abundant univoltine species (*sospeta* Dru.) and a variably common bivoltine one (*urticaria* Swett). The relative numbers of the two vary from locality to locality, but both are usually present. Their flight periods are essentially constant throughout the range. Fig. 2 shows the flight periods of these two

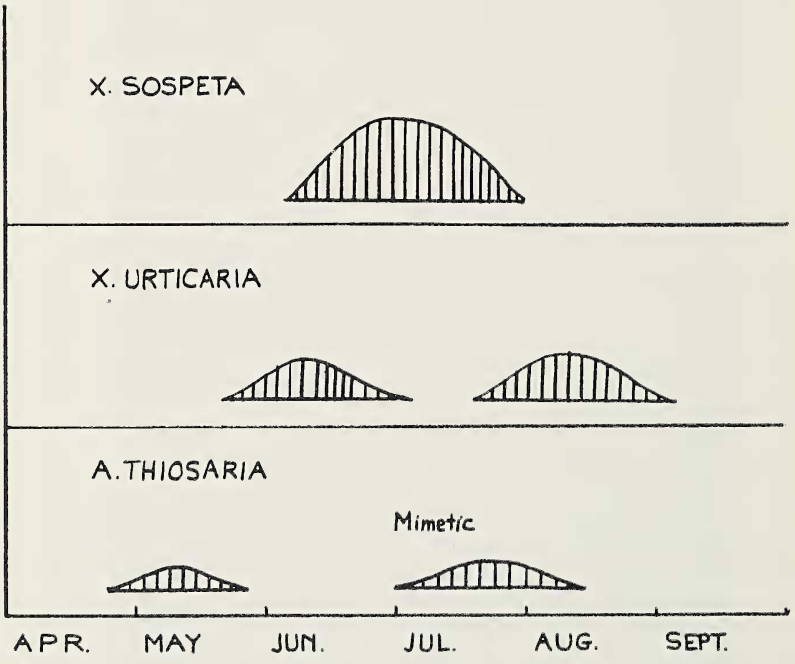

Fig. 2. Flight periods and relative abundance of models and mimic in Pennsylvania.

insects and the presumed mimic in Pennsylvania; they may be taken as representative. The relative abundance shown is average for that State. From Delaware south there is another species, *X. rufaria* Swett., univoltine with the flight in June in Florida and South Carolina and late June-early July in Delaware and Maryland. *A. thiosaria* ranges south to Tennessee and (reported from) northern Mississippi.

It is quite clear that the summer flight of *thiosaria* coincides with the second half of the flight of *sospeta* and the first of the second brood of *urticaria*. The non-mimic spring brood of *thiosaria* generally does not overlap any *Xanthotype* at all.

There are no records available on the palatability of the species of *Xanthotype*. Its conspicuous coloration and behavior suggests, however, that the genus is highly protected. The moths are partially diurnal. They normally sit in low vegetation during the day, with some spontaneous flight activity in the early morning and in the evening, and occasionally in bright sunlight. They are often to be found at rest in exposed situations. When aroused from rest their flight is sluggish and conspicuous. *A. thiosaria* is nocturnal and rests in low vegetation and on the ground by day. It is generally better concealed when at rest than are the species of *Xanthotype*. When alarmed its flight is quick and active, but its coloration (particularly that of females) is fully as conspicuous as that of the probably protected species.

It is quite possible that the failure to copy the flight characteristics of the model reflects the seasonal coloration switch from a concealing to a mimetic pattern; the spring form must move quickly. The resemblance in flight, especially in the female *thiosaria*, is very striking nonetheless and often the two cannot be discriminated with certainty until in the net.

The patterns of nocturnal moths are generally assumed to have evolved in response to visual-predation selective influence operating in daylight, when the insects are at rest. All the evidence so far available suggests that coloration has no role in the activities of moths which are carried out in darkness (e.g. in mating; the striking absence of conspicuous sexual dimorphism in most nocturnal moths bears witness to this), or in nocturnal predation. The failure to recognize the existence of mimicry in nocturnal moths has probably resulted from an incomplete appreciation of this fact.

The opportunity for *thiosaria* to benefit from its resemblance to *Xanthotype* is enhanced by the habit, shared by both, of

walking about and waving the wings prior to taking flight (except when extremely agitated). This activity is most conspicuous when the moth had been resting on the ground or otherwise in a fairly open situation. In the absence of further provocation the moth may settle again without taking flight. A bird conditioned to avoid the *Xanthotype* color and pattern might then not have to startle the insect o actual flight to be deterred from eating it. This walking-waving behavior is found in a variety of Geometridae, including such diverse groups as *Erannis* and *Semiothisa,* but not in the immediate relatives of *Antepione* (*Prochoerodes, Abbotana*) in North America, at least.

The sexual dimorphism of summer *thiosaria* may reflect a recent origin for the mimicry (as does, perhaps, the lack of summer flight modifications). Female mimetism is, however, quite common and well known in the Lepidoptera (e.g., the famous *Papilio dardanus,* and the presumed mimic *P. glaucus* and *P. polyxenes* in the U.S.A.). The mal *thiosaria* is really a fairly effective copy of dark male *Xanthotype* in flight and when walking-waving; certainly more so than the set specimens would indicate. The inferiority to the resemblance in the female is, however, very evident.

So far as is known, *thiosaria* is always less abundant than the local *Xanthotype,* and sufficiently so to make the resemblance profitable and prevent counterconditioning. At Philadelphia, Pa. the overall ratio is usually about 7.5:1; in eastern Maryland, about 12:1; in central Massachusetts about 7:1. (Light-trap data are not in themselves reliable since *Xanthotype* are less attracted to both white light and UV than is *A. thiosaria.*) In practice, predators may have considerably less contact with the mimic than even its numbers would indicate, since its habits by day are much more secretive than those of the model and the resemblance is shown conspicuously only in time of peril.

In summary, then, the postulated mimicry association fulfills the fundamental requirements for such a relationship, viz.:

1. The (presumed) model exhibits bright, warning-type coloration, and its behavior indicates that it is highly protected.

2. The presumed mimic has departed significantly from the normal coloration of its relatives (and in this case, in having a marked seasonal dimorphism).

3. The mimic is sufficiently rare in comparison to the model to insure an advantage to the former.

4. The two insects are properly associated spatially (sympatric) and temporally (synchronous, or the model partially preceding the mimic).

5. The resemblance is conspicuously displayed to potential predators.

The case of *Antepione thiosaria* seems to be the only described instance where mimicry is confined to one of multiple generations, coinciding with the active period of the model. It also is the only described case where the mimetic coloration is produced by an environmentally controlled switch mechanism defined genetically, instead of by a direct genetic morphism. This is a common device where different phenotypes have different values in the various generations, and its application to mimicry was predictable. The case of *A. thiosaria* is probably far from unique, although the utilization of a seasonal mechanism would not be expected in the humid tropics where so many mimicry associations occur; further examples are to be sought primarily in temperate areas.